Description

Dual Band Sleeve Antenna

BACKGROUND OF INVENTION

[0001] Background of the Invention

[0002] 1. Field of the Invention

[0003] The invention relates to dual-band antennas. More specifically, in a preferred embodiment, the invention relates to a cost efficient antenna tunable for use with both 802.11a and 802.11b/g "Wi-Fi" frequency bands.

[0004] 2. Description of Related Art

[0005] Digital wireless systems, for example wireless local area computer networks, utilize frequency bands allocated for use by specific communication protocols. To provide users with increased connectivity options, it is desirable to provide multiple protocol capability. Because the standardized "Wi-Fi" protocols are not allocated to frequency bands that are harmonically related to each other, it has been difficult to provide a cost effective single antenna

solution with acceptable dual band performance.

[0006] Sleeve chokes are a known method for tuning a whip and or dipole antenna. Typically the choke is a ¼wavelength sleeve a distal end coupled to an outer conductor of a coaxial feed or a proximal end of the inner conductor. The inner conductor of the coaxial feed forms an antenna element that extends beyond the sleeve for ¼wavelength of the target frequency. Because the choke and the extending antenna element are both ¼ wavelength of the target frequency, it is difficult to tune the resulting antenna to dual bands that are not harmonically related.

[0007] To achieve acceptable dual band performance, prior dual band antenna configurations have used multiple concentric and or mechanically interconnected at one end sleeve/ choke assemblies. However, these configurations have increased cost and manufacturing tolerance requirements. Further, the resulting antenna has an increased diameter to accommodate the additional concentric sleeve(s).

[0008] Competition within the antenna industry has focused attention on dual band capability within a single antenna, minimization of antenna size, materials and manufacturing costs.

[0009] Therefore, it is an object of the invention to provide an

antenna, which overcomes deficiencies in the prior art.

BRIEF DESCRIPTION OF DRAWINGS

[0010] The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and, together with a general description of the invention given above, and the detailed description of the embodiments given below, serve to explain the principles of the invention.

[0011] Fig. 1 shows an external isometric view of a first embodiment of the invention.

[0012] Fig. 2 shows a center section side view of figure 1, along with representative electrical couplings related to the sleeve element.

[0013] Fig. 3a is a 2.4 MHz polar radiation pattern model of the first embodiment.

[0014] Fig. 3b is a 5.5 MHz polar radiation pattern model of the first embodiment.

[0015] Figure 4 is test data of standing wave ratios versus frequency, for the first embodiment.

[0016] Figure 5 is an external isometric view of a three band embodiment of the invention wherein the ground plane is a patch element for a second antenna. Antenna feeds and hidden lines omitted for clarity.

Detailed Description

[0017] A first embodiment of the antenna 1 is shown in Figure 1. An antenna element 2 is fed through an aperture in a ground plane 4 upon which, insulated by a dielectric spacer 6 a sleeve 8 is supported generally concentric about the antenna element 2. The antenna 1 may be fed, for example, by a coaxial cable 9 having an inner conductor 10 coupled to the antenna element 2 and an outer conductor 12 coupled to the ground plane 4.

[0018] In the preferred embodiment, the sleeve 8 has a simple tubular configuration without annular radiuses or other electrically interconnecting structure previously applied to prior "choke" elements. The sleeve element 8 is electrically insulated by the dielectric spacer 6 from direct contact with the ground plane 4 and by the air gap 13 differential between the outer diameter of the antenna element 2 and the inner diameter of the sleeve 8.

[0019] When fed with an RF signal, the sleeve 8 becomes capacitively coupled both to the ground plane 4 and to the antenna element 2 as shown schematically in figure 2 by sleeve-antenna capacitive coupling 14 and sleeve-ground plane capacitive coupling 16.

[0020] By varying the lengths and diameters of the antenna ele-

ment 2 and sleeve 8, along with the thickness and or dielectric properties of the dielectric spacer 6 the antenna 1 may be tuned for response to at least 2 target bands. Similarly, the air gap 13 between the sleeve 8 and the antenna element 2 may be filled with a desired dielectric material, allowing further manipulation of the resulting value of the antenna-sleeve capacitive coupling 14 in addition to modification of the associated element dimensions.

[0021] A suitable dielectric spacer 6 material is standard printed circuit board substrate. Alternatively, the dielectric spacer 6 may be, for example, a dielectric surface coating, for example PTFE, applied to the ground plane 4 and or sleeve 8.

[0022] Applicant has developed configurations wherein the higher target band is more than twice the frequency of the lower target band. Many iterations of the different dimensional variables may be quickly optimized for desired target frequencies by one skilled in the art using method of moments electromagnetic modeling software, available for example from Zeland Software, Inc. of Fremont, California, USA.

[0023] Theoretical models and test data for a first embodiment

modeled for dual Wi-Fi frequency bands of approximately 2.4 and 5.5 MHz is shown in figures 3a, 3b, and 4. Selected dimensions of the antenna 1 for the embodiment shown are as follows:antenna element 2: 29 mm long, 1.6mm diametersleeve 8: 15.5mm long, 7.2mm diameter-dielectric spacer 6: 0.02"thick, dielectric constant = 3.38 As shown by the electrical models and resulting test data, the antenna 1 configuration provides uniform radiation patterns and standing wave ratio performance of less than 1.7 across two non-harmonically related frequency bands. Further, the antenna has a greatly simplified mechanical structure that is cost effective to manufacture from standard, commonly available materials with minimal machining and or metal forming requirements.

[0024] The antenna is extremely compact, and may be further integrated with other antenna elements. As shown in Figure 5, the ground plane 4 described herein may be the radiator of a, for example, GPS or SDAR antenna module formed with a patch antenna element 5, creating a tri-band antenna assembly. Patch antennas and their construction / dimensions for specific frequency bands, being well known in the art, are not further disclosed here. Because the antenna elements are electrically isolated from

direct interconnection with the ground plane 4, when the ground plane 4 is a patch antenna element 5, degradation of the patch antenna element 5 operating characteristics, if any, is acceptable.

[0025] The antenna has been demonstrated with respect to dual Wi-Fi frequency bands. Alternatively, the antenna dimensions may be designed for different target frequency bands. The antenna element dimensions and spacing being appropriately adjusted to match the midpoint frequencies of the chosen target frequency bands for the best overall performance.

Table of Parts

1	antenna
2	antenna element
4	ground plane
5	patch antenna element
6	dielectric spacer
8	sleeve
9	coaxial cable
10	inner conductor
12	outer conductor
13	air gap
14	sleeve-antenna capacitive coupling
16	sleeve-ground plane capacitive coupling

[0026] Where in the foregoing description reference has been made to ratios, integers or components having known equivalents then such equivalents are herein incorporated as if individually set forth.

[0027] While the present invention has been illustrated by the description of the embodiments thereof, and while the embodiments have been described in considerable detail, it is not the intention of the applicant to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will readily appear to those skilled in the art. Therefore, the invention in its broader aspects is not limited to the specific details representative apparatus and method, and illustrative examples shown and described. Accordingly, departures may be made from such details without departure from the spirit or scope of applicant's general inventive concept. Further, it is to be appreciated that improvements and/or modifications may be made thereto without departing from the scope or spirit of the present invention as defined by the following claims.